

The following Listing of Claims will replace all prior versions, and listings, of claims in the application.

Listing of the Claims:

1. (Original) A graphics processing method, comprising:
defining a plurality of rows of tiles in a graphics display field comprising a plurality of rows of pixels, each tile including pixels from at least two rows of pixels;
setting occlusion flags for respective tiles of a row of tiles for a graphics primitive based on whether respective representative depth values for the tiles of the row of tiles meet an occlusion criterion;
processing pixels in rows of pixels corresponding to the row of tiles for the graphics primitive in a row-by-row manner responsive to the occlusion flags.
2. (Original) A method according to Claim 1, wherein processing pixels comprises:
processing a portion of the pixels in a first tile of the row of tiles responsive to the occlusion flags; and then
possibly processing pixels in a second tile of the row of tiles responsive to the occlusion flags before processing additional pixels in the first tile responsive to the occlusion flags.
3. (Original) A method according to Claim 2, wherein processing pixels comprises processing rows of pixels in the row of tiles using a zig-zag traversal algorithm.
4. (Original) A method according to Claim 2:
wherein the occlusion flags are stored in a tile occlusion information cache that is configured to store respective occlusion flags for respective tiles of a row of tiles and respective occlusion threshold depth values for the respective tiles of the row of tiles; and
wherein setting occlusion flags comprises:
determining a maximum depth value for the graphics primitive for a tile;

comparing the maximum depth value to the cached occlusion threshold depth value for the tile in the tile occlusion information cache; and
setting the occlusion flag for the tile responsive to the comparison.

5. (Original) A method according to Claim 4, further comprising:
establishing a depth buffer configured to store respective occlusion threshold depth values for respective pixels of the graphics display field; and
wherein setting the occlusion flags comprises setting an occlusion flag for a tile to indicate non-occlusion; and

wherein processing pixels comprises:

detecting that the tile has a occlusion flag indicating non-occlusion; and
responsively processing a pixel for the graphics primitive in the tile without retrieving an occlusion threshold depth value for the pixel from the depth buffer.

6. (Original) A method according to Claim 5, further comprising establishing a color buffer configured to store respective color values for respective ones of the pixels of the graphics display field, and wherein responsively processing a pixel for the graphics primitive in the tile without retrieving an occlusion threshold depth value for the pixel from the depth buffer comprises responsively storing a color value and a depth value for the graphics primitive for the pixel in the color buffer and the depth buffer, respectively.

7. (Original) A method according to Claim 6, wherein the occlusion flags are stored in a tile occlusion information cache that is configured to store respective occlusion flags for respective tiles of a row of tiles, respective occlusion threshold depth values for the respective tiles of the row of tiles, and wherein the method further comprises:

determining a depth value for the graphics primitive for the pixel;
comparing the determined depth value for the graphics primitive for the pixel to the occlusion threshold depth value for the tile in the tile occlusion information cache; and
updating the occlusion threshold depth value for the tile in the tile occlusion information threshold cache to the determined depth value for the graphics primitive for the pixel responsive to the comparison.

8. (Original) A method according to Claim 7:

wherein setting occlusion flags comprises setting an occlusion flag for a tile to indicate non-occlusion, and wherein processing pixels is preceded by:

establishing an aggregate tile occlusion information memory configured to store respective occlusion threshold depth values for all of the rows of tiles; and

loading the tile occlusion information cache with occlusion threshold depth values from the aggregate tile occlusion information memory; and

wherein updating the occlusion threshold depth value for the tile in the tile occlusion information threshold cache is followed by updating threshold occlusion depth values in the aggregate tile occlusion information memory from the tile occlusion information cache.

9. (Original) A method according to Claim 1, further comprising:

establishing a depth buffer configured to store respective occlusion threshold depth values for respective pixels of the graphics display field; and

wherein setting occlusion flags comprises setting the occlusion flag for a tile to indicate possible occlusion; and

wherein processing pixels comprises:

detecting that the tile has an occlusion flag indicating possible occlusion; and

comparing a depth value for the graphics primitive for a pixel in the tile to an occlusion threshold depth value for the pixel in the depth buffer responsive to

detecting that the tile has an occlusion flag indicating possible occlusion;

processing the pixel responsive to the comparison; and

updating the occlusion threshold depth value for the tile in the tile occlusion information cache responsive to the written z-value of the pixel.

10. (Original) A method according to Claim 9, further comprising establishing a color buffer configured to store respective color values for respective ones of the pixels of the graphics display field, and wherein processing the pixel comprises storing a color value and a depth value in the color buffer and the depth buffer, respectively, if the comparison of the depth value for the graphics primitive for the pixel in the tile to the occlusion threshold depth

value for the pixel in the depth buffer indicates non-occlusion and updating the occlusion threshold depth value for the tile in the tile occlusion information cache responsive to the written z-value of the pixel.

11. (Original) A method according to Claim 1, wherein the occlusion flags are stored in a tile occlusion information cache that is configured to store respective occlusion flags for respective tiles of a row of tiles, respective occlusion threshold depth values for the respective tiles of the row of tiles, and respective status flags for respective tiles of the row of tiles, and wherein the method further comprises:

processing a first row of pixels responsive to the tile occlusion information cache, wherein processing a first row of pixels comprises setting occlusion and status flags for at least one tile in the first row of tiles to indicate that occlusion status of the at least one tile has been determined;

determining whether a second row of pixels is in the first row of tiles; and

processing a second row of pixels using information in the tile occlusion cache gained from the first row of pixels if the second row of pixels is in the first row of tiles.

12. (Original) A method according to Claim 11, wherein processing a first row of pixels is preceded by:

establishing an aggregate tile occlusion information memory configured to store respective occlusion threshold depth values for all tiles in all rows of tiles;

setting the occlusion and status flags in the tile occlusion information cache to predetermined values; and

storing occlusion threshold depth values for the first row of tiles from the aggregate tile occlusion information memory in the tile occlusion information cache.

13. (Original) A method according to Claim 1, wherein the occlusion flags are stored in a tile occlusion information cache that is configured to store respective occlusion flags for respective tiles of a row of tiles, respective occlusion threshold depth values for the respective tiles of the row of tiles, and respective status flags for respective tiles of the row of tiles, and wherein the method further comprises:

establishing an aggregate tile occlusion information memory configured to store respective occlusion threshold depth values for all tiles of the rows of tiles;

processing a first row of pixels responsive to the tile occlusion information cache, wherein processing a first row of pixels comprises setting occlusion flags and status flags for a first row of tiles having pixels in the first row of pixels to indicate that at least one occlusion status of at least one tile in the first row has been determined;

determining whether a second row of pixels is in the first row of tiles; and

responsive to determining that the second row of pixels is in a second row of tiles, writing back the occlusion threshold depth values from the tile occlusion information cache to the aggregate tile occlusion information in the tile occlusion information cache, loading occlusion threshold depth values into the tile occlusion information cache with corresponding occlusion threshold depth values for the second row of tiles from the aggregate tile occlusion information memory, and processing the second row of pixels using the updated tile occlusion cache.

14. (Original) A method according to Claim 13, wherein determining whether a second row of pixels is in the first row of tiles is followed by updating occlusion threshold depth values for the first row of tiles in the aggregate tile occlusion information memory with occlusion threshold depth values from the tile occlusion cache responsive to determining that the second row of pixels is in a second row of tiles.

15. (Original) An apparatus, comprising:
a display; and

a graphics processor coupled to the display and operative to define a plurality of rows of tiles in a graphics display field of the display, each tile including pixels from at least two rows of pixels, to set occlusion flags for respective tiles of a row of tiles for a graphics primitive based on whether respective representative depth values for the tiles of the row of tiles meet an occlusion criterion, and to process pixels in rows of pixels corresponding to the row of tiles for the graphics primitive in a row-by-row manner responsive to the occlusion flags.

16. (Original) An apparatus according to Claim 15, wherein the graphics processor is operative to process a portion of the pixels in a first tile of the row of tiles responsive to the occlusion flags and to then process pixels in a second tile of the row of tiles responsive to the occlusion flags before processing additional pixels in the first tile responsive to the occlusion flags.

17. (Original) An apparatus according to Claim 15, wherein the graphics processor is operative to process rows of pixels in the row of tiles using a zig-zag traversal algorithm.

18. (Original) An apparatus according to Claim 15, wherein the representative depth values comprise maximum depths of the graphics primitive in the tiles, and wherein the occlusion criterion is whether a maximum depth for the graphics primitive in the tile is less than a previously established minimum non-occlusion depth value for the tile.

19. (Original) An apparatus according to Claim 15, wherein the display and the graphics processor are housed in a portable electronic device.

20. (Original) An apparatus, comprising:
a display; and
a graphics processor coupled to the display and operative to define a plurality of rows of tiles in the graphics display field, each of the tiles comprising a plurality of pixels, to set an occlusion flag for a tile to indicate non-occlusion for a graphics primitive in the tile, to detect that the tile has a occlusion flag indicating non-occlusion, and to responsively process a pixel for a graphics primitive in the tile.

21. (Original) An apparatus according to Claim 20, wherein the graphics processor is operative to maintain a depth buffer configured to store respective occlusion threshold depth values for respective pixels of a graphics display field of the display and to process the pixel without retrieving an occlusion threshold depth value from the depth buffer.

22. (Original) An apparatus according to Claim 20, wherein the graphics processor is operative to maintain a tile occlusion information cache that is configured to store respective occlusion flags for respective tiles of a row of tiles and respective occlusion threshold depth values for the respective tiles of the row of tiles, to determine a maximum depth value for the graphics primitive for a tile, to compare the maximum depth value to the cached occlusion threshold depth value for the tile in the tile occlusion information cache, and to set the occlusion flag for the tile responsive to the comparison.

23. (Original) A computer program product comprising program code embodied in a computer-readable medium, the program code comprising:

program code configured to define a plurality of rows of tiles in a graphics display field of the display, each tile including pixels from at least two rows of pixels, to set occlusion flags for respective tiles of a row of tiles for a graphics primitive based on whether respective representative depth values for the tiles of the row of tiles meet an occlusion criterion, and to process pixels in rows of pixels corresponding to the row of tiles for the graphics primitive in a row-by-row manner responsive to the occlusion flags.

24. (Original) A computer program product according to Claim 23, wherein the program code is further configured to process a portion of the pixels in a first tile of the row of tiles responsive to the occlusion flags and to then process pixels in a second tile of the row of tiles responsive to the occlusion flags before processing additional pixels in the first tile responsive to the occlusion flags

25. (Original) A computer program product according to Claim 24, wherein the program code is further configured to process rows of pixels in the row of tiles using a zig-zag traversal algorithm.

26. (Original) A computer program product comprising program code embodied in a computer-readable medium, the program code comprising:

program code configured to define a plurality of rows of tiles in the graphics display field, each of the tiles comprising a plurality of pixels, to set an occlusion flag for a tile to

indicate non-occlusion for a graphics primitive in the tile, to detect that the tile has a occlusion flag indicating non-occlusion, and to responsively process a pixel for a graphics primitive in the tile.

27. (Original) A computer program product according to Claim 26, wherein the program code is further configured to maintain a depth buffer configured to store respective occlusion threshold depth values for respective pixels of a graphics display field of the display and to process the pixel without retrieving an occlusion threshold depth value from the depth buffer.

28. (Original) A computer program product according to Claim 1, wherein the program code is configured to maintain a tile occlusion information cache that is configured to store respective occlusion flags for respective tiles of a row of tiles and respective occlusion threshold depth values for the respective tiles of the row of tiles, to determine a maximum depth value for the graphics primitive for a tile, to compare the maximum depth value to the cached occlusion threshold depth value for the tile in the tile occlusion information cache, and to set the occlusion flag for the tile responsive to the comparison.

29. (New) A graphics processing method, comprising:
defining a plurality of tiles in a graphics display field, each tile comprising a plurality of pixels;
determining a maximum depth value for a graphic primitive;
setting an occlusion flag for a tile responsive to a comparison of a previously-determined minimum depth value for the tile to the maximum depth value for the graphics primitive; and
processing a pixel for the graphics primitive responsive to the occlusion flag.

30. (New) A method according to Claim 29, wherein setting an occlusion flag for a tile responsive to a comparison of a previously-determined minimum depth value for the tile to the maximum depth value for the graphics primitive comprises setting the occlusion flag to indicate that the graphics primitive is not occluded in the tile responsive to the

minimum depth value for the tile exceeding the maximum depth value for the graphics primitive.

31. (New) A method according to Claim 30, wherein processing a pixel for the graphics primitive responsive to the occlusion flag comprises rendering the pixel without comparing a depth value thereof to an occlusion threshold value responsive to detecting that the occlusion flag indicates that the graphics primitive is not occluded in the tile.

32. (New) A method according to Claim 29, wherein the maximum depth value represents a depth greater than or equal to all possible depth values that the graphics primitive may have in a tile

33. (New) A method according to Claim 32, wherein determining a maximum depth value comprises determining a maximum depth of vertices of the graphics primitive.

34. (New) A method according to Claim 32, wherein determining a maximum depth value comprises determining a maximum depth of a plane of the graphics primitive in the tile.

35. (New) A method according to Claim 29, further comprising establishing a tile occlusion information cache that is configured to store respective occlusion flags for respective tiles of a row of tiles and respective minimum depth values for the respective tiles of the row of tiles, and wherein setting an occlusion flag for a tile responsive to a comparison of a previously-determined minimum depth value for the tile to the maximum depth value for the graphics primitive comprises:

comparing the maximum depth value to a minimum depth value for the tile in the tile occlusion information cache; and

setting an occlusion flag for the tile in the tile occlusion information cache responsive to the comparison.

36. (New) A method according to Claim 29, wherein the tile comprises a first tile in a row of tiles, each row of tiles including at least two rows of pixels, and further comprising processing pixels for the graphics primitive in a row-by-row fashion.

37. (New) A method according to Claim 36, wherein processing pixels for the graphics primitive in a row-by-row fashion comprises processing the graphics primitive using a zig-zag traversal algorithm.

38. (New) A method according to Claim 29, further comprising:
processing a first portion of a first tile for the graphics primitive;
processing at least a portion of a second tile for the graphics primitive; and then
processing a second portion of the first tile for the graphics primitive.

39. (New) An apparatus comprising a graphics processor configured to perform the method of Claim 29.

40. (New) A computer program product comprising program code embodied in a computer-readable medium, the program code comprising program code configured to perform the method of Claim 29.